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A SIMPLE, LINEAR COUNT-RATE INDICATOR FOR ACOUSTIC EMISSION.(U)

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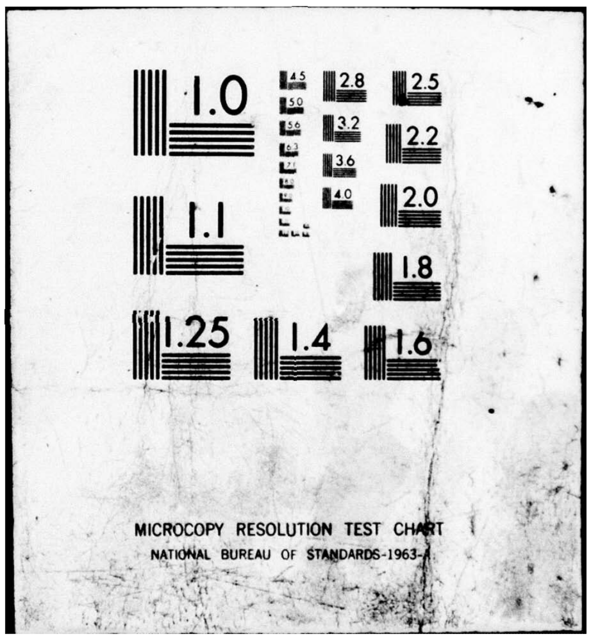
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MATERIALS NOTE 118

A SIMPLE, LINEAR COUNT-RATE INDICATOR FOR ACOUSTIC EMISSION

by

I. G. SCOTT

Approved for Public Release

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(6) A SIMPLE, LINEAR COUNT-RATE INDICATOR FOR ACOUSTIC EMISSION.

by

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SUMMARY

A simple indicator of acoustic emission activity, which can be made from readily available components, is described.

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ABSTRACT

A simple indicator of acoustic emission activity, which can be made from readily available components, is described.

CONTENTS

1. INTRODUCTION

Acoustic emission (AE) measurements have usually been made using a ring-down counting technique (Brindley et al.) wherein the signal excursions above a threshold level are counted, using an arrangement similar to that shown in figure 1. The expense and complication of both counter and converter may be considered to be unwarranted, particularly in multiple transducer situations. Consequently, a replacement system was sought having essentially a D.C. output or, at least, an output which could be readily recorded.

Ring-down counting provides a qualitative indication of AE activity rather than an accurate quantitative measure of some AE property. Except in special circumstances, it is impossible to differentiate between high count rates arising from large numbers of small events or a few large events. By totalising counts, rather than measuring count rates, large events can be identified but thereby much important detail is likely to be lost.

For particularly energetic events, the amplifier output can be rectified (using a fast rectifier) and smoothed sufficiently to permit the use of simple recorders. In the smoothing process, all evidence of small signals is lost (few people work at frequencies below 50 kHz and hence many counts are necessary before a recordable signal results). Rectified signals can also be used as input to a voltage-controlled ramp—by choosing a suitable ramp period, an accurate measure of count rates can be obtained. This was not developed in the present study because suitable components were not available at the time.

2. DESCRIPTION OF INSTRUMENT

In the method chosen here the fraction (x) of the counting period time (t) for which the signal exceeds the threshold is measured. This is done by means of an integrator (figure 2) in which a condenser C is charged through a resistance R during time xt. At the end of the counting period, the accumulated charge on the condenser is measured before it is discharged. The control circuit is shown in figure 3. A master oscillator produces square waves having about a three-second period. On the positive-going side of the wave, a monostable multivibrator (74121) is energised and produces a logic pulse of controlled length. The negative-going side of this pulse controls a second multivibrator which produces a second logic pulse. These pulses are used for driving the relays which permit the charge on the condenser to be sampled and allow the condenser to be discharged.

The main unit is shown in figure 4 and comprises a comparator, integrator and sample-and-hold device. Zener diodes are used to stabilise the threshold control voltage. Signals exceeding this predetermined voltage level produce logic pulses at the comparator output. The integrator is provided with a drift-correction circuit which was found essential for the IC's used. The condenser C is discharged through the resistor R_d by the closing of the reed relay contacts. The integrator time constant is given by RC. Balance correction is needed on the 301A sample-and-hold unit. Provided IC's are selected, leakage problems are not likely to appear over a three-second period.

Design requirements are quite simple. The product RC determines full scale for the unit; for large signals, a larger time constant would probably be chosen but, in low signal studies, the maximum sensitivity is needed. Once RC has been chosen, C_s follows—if C_s is large compared with C, sampling times may be too long, whereas if it is too small, charge cannot readily be retained. Sampling times can normally be kept to a small fraction of recording times.

The charging characteristic of a condenser is non-linear and is given by

$$V = V_f\left(1 - e^{-\frac{T}{RC}}\right)$$

where V and V_f are the instantaneous and final voltages respectively, and T is the time. However, provided $t \ll RC$, a near-linear V—T characteristic can be expected. D.C. signals were fed to the comparator input simultaneously with a 60 kHz signal fed to a counter. The subsequent calibration is shown in figure 5. The count rate is a near-linear function of the output voltage until a clearly observed saturation condition is reached.

3. CONCLUDING REMARKS

The prototype unit has been used in several situations involving continuous recording over long time intervals. It has performed satisfactorily, only minor adjustments being needed. It was made from readily available, cheap components using two printed circuit boards and was housed in a box 100 x 75 x 55 mm. No difficulty should be experienced in making a much smaller unit. Obvious refinements would include the use of solid state switches, selectable sensitivities and sample-and-hold IC's.

REFERENCE

Brindley, B. J., Holt, J. and Palmer, I. G. — 'The use of ring-down counting'. Non-destructive Testg., December 1973, pp. 299–306.

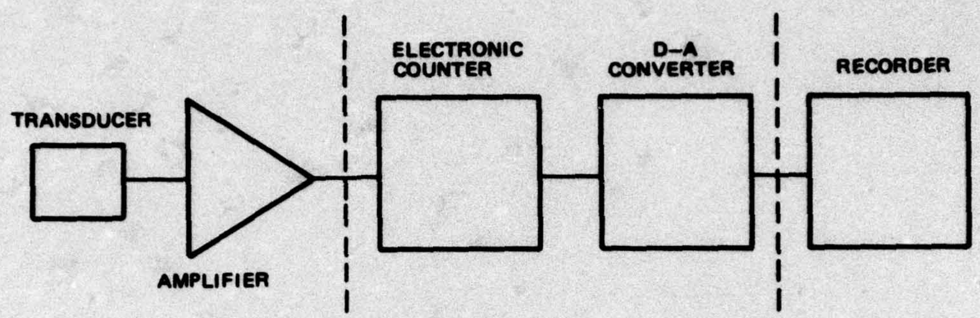

FIG. 1 CONVENTIONAL SYSTEM – SCHEMATIC

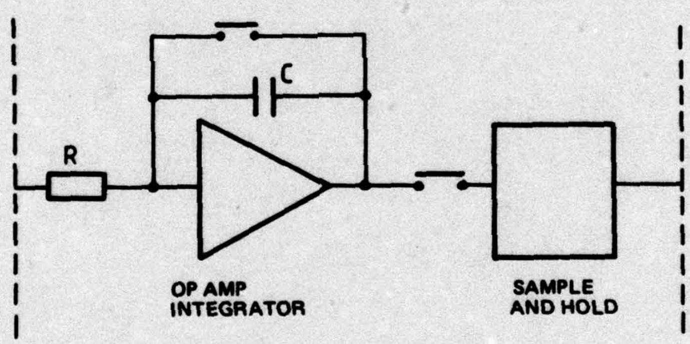

FIG. 2 PROPOSED SYSTEM – SCHEMATIC

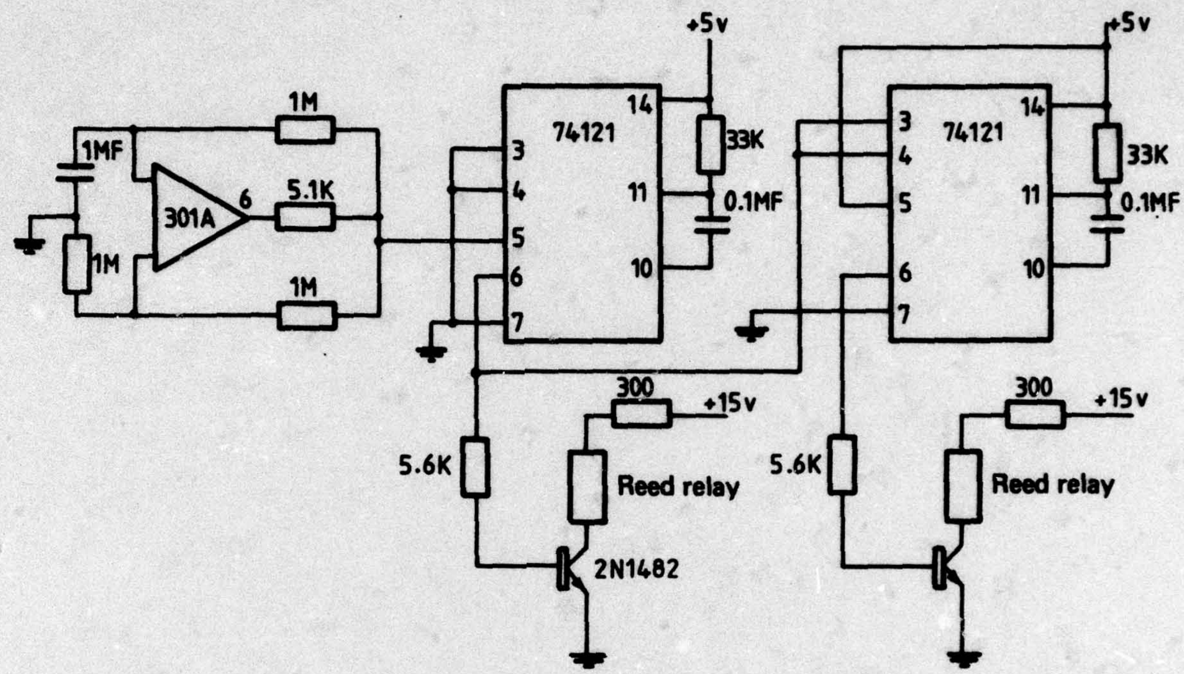

FIG. 3 CONTROL CIRCUITS

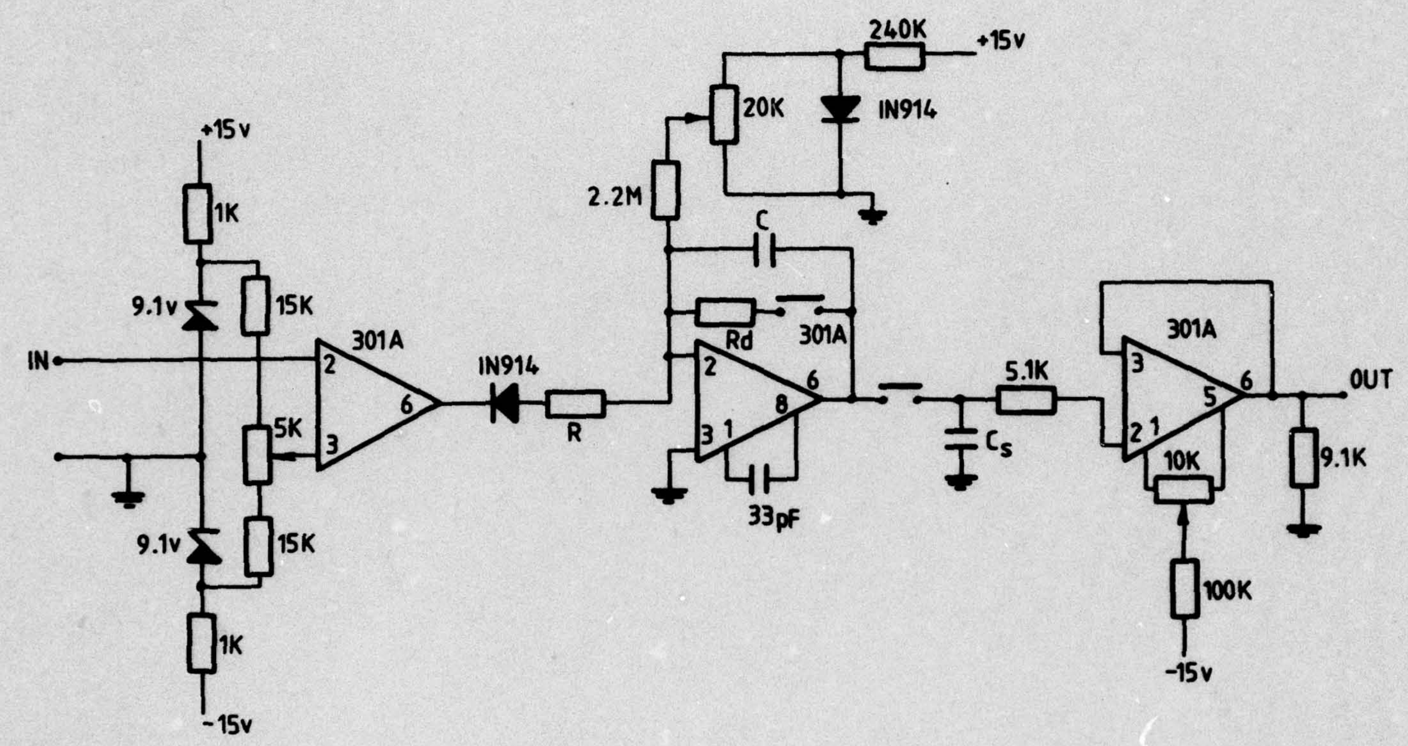

FIG. 4 SIGNAL CIRCUITS

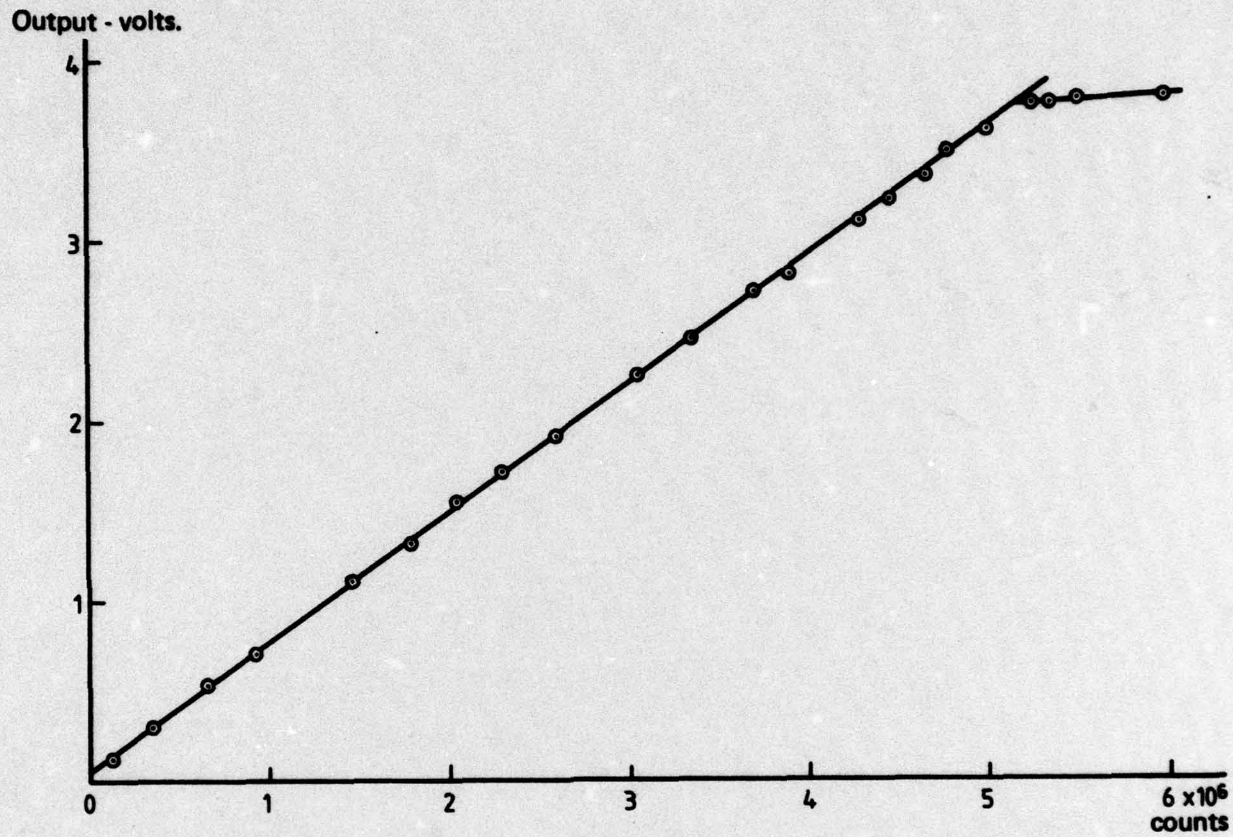

FIG. 5 CALIBRATION OF COUNT-RATE INDICATOR

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